



Social Media: Space Weather

#SpaceWeather

Please help the NWS spread these important safety messages on social media! Everyone is welcome to use the text and images provided below to help the NWS build a Weather-Ready Nation.

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Space Weather Safety Page

Facebook

Check out the new NWS Space Weather Safety page to find out how a space weather event can impact you. www.nws.noaa.gov/om/space #SpaceWeather

Twitter

Check out the new NWS Space Weather Safety page! www.nws.noaa.gov/om/space #SpaceWeather



The screenshot shows the National Weather Service (NWS) website's Space Weather section. At the top, the NWS logo and "NATIONAL WEATHER SERVICE" are displayed, along with the "NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION" tagline. A navigation bar includes links for HOME, FORECAST, PAST WEATHER, WEATHER SAFETY, INFORMATION CENTER, NEWS, SEARCH, and ABOUT. Below this, a row of buttons includes "Space Weather" (highlighted), "Warnings and Watches", "Before a Solar Event", "During a Solar Event", and "After a Solar Event". To the right is a "WPN" logo. The main content area features a large image of a coronal mass ejection (CME) erupting from the sun, with the caption "Coronal Mass Ejection erupting from sun: NASA/Solar Dynamics Observatory". To the right of the image is a sidebar titled "Space Weather" containing a list of links: "Space Weather", "Space Weather Prediction Center", "Space Weather Scales", "Space Weather Impacts", "Space Weather Glossary", "Outreach and Education", and "Links and Partners".

Space Weather and Safety

In order to protect people and systems that might be at risk from space weather effects, we need to understand the causes. The sun is the main source of space weather. Eruptions of plasma and magnetic field structures from the sun's atmosphere, called coronal mass ejections (CMEs), and sudden bursts of radiation, called solar flares, can cause space weather effects at or near Earth. Luckily, Earth's magnetosphere, ionosphere, and atmosphere do a great job of protecting us from the most hazardous effects.

What is Space Weather and What are the Impacts?

Facebook

We rely on advanced technology for almost everything we do. Satellite communications, GPS applications, and the electric power grid provide the backbone of our nation's economic vitality and security. These technologies are vulnerable to a threat from space—our Sun! To learn about space weather visit www.swpc.noaa.gov #SpaceWeather

Introduction to Space Weather:

<https://www.youtube.com/watch?v=JncTCE2NWgc&list=PLBdd8cMH5jFmvVR2sZubIUzBO6JI0Pvx0&index=1>

Twitter

Satellites, GPS, the power grid, and more can be vulnerable to a threat from space—our Sun!

Learn more www.swpc.noaa.gov #SpaceWeather



Space Weather Impacts on Communications

Facebook

Effective communication systems can mean the difference between life and death. Aviation and emergency response communities depend on reliable communications. Radio and satellite communication technologies can experience significant degradation from space weather storms. To learn about space weather impacts visit: <http://www.swpc.noaa.gov/impacts> #SpaceWeather

Check out this video on how space weather impacts communications:

https://youtu.be/7vFGTI_Cp6I

Twitter

Communications systems are critical to our Nation and are vulnerable to the Sun!

<http://www.swpc.noaa.gov/impacts> #SpaceWeather



Space Weather Impacts on GPS

Facebook

GPS technology has changed society. Oil drilling, aviation, surveying, precision agriculture, and emergency response all rely on GPS. Space weather storms can interfere with the high accuracy of GPS leading to errors or even the complete loss of GPS capabilities. To learn about space weather visit: <http://www.swpc.noaa.gov/impacts/space-weather-and-gps-systems> #SpaceWeather

Check out this video on how space weather impacts GPS:
<https://www.youtube.com/watch?v=V4rSC6Hje0E>

Twitter

GPS technology can be vulnerable to a threat from space—our Sun! Space Weather storms can interfere with the accuracy and availability of GPS. Learn more
<http://www.swpc.noaa.gov/impacts/space-weather-and-gps-systems> #SpaceWeather



Space Weather Impacts on the Power Grid

Facebook

The electric power grid, and consequently the power to your home or business, can be disrupted by space weather. Extreme geomagnetic storms can create significant impacts, damaging critical assets and even causing blackouts in rare cases. To learn about space weather and impacts to the electric grid visit

<http://www.swpc.noaa.gov/impacts/electric-power-transmission> #SpaceWeather (Photo: U.S. Department of Energy)

Space Weather Impacts on Power Grid.

<https://www.youtube.com/watch?v=caHYgTf6tO8&list=PLBdd8cMH5jFmvVR2sZubIUzBO6JI0Pvx0&index=4>

Twitter

Power grids are vulnerable to a threat from space—our Sun!

<http://www.swpc.noaa.gov/impacts/electric-power-transmission> #SpaceWeather (photo: @DOE)



Space Weather and the Aurora Borealis

Facebook

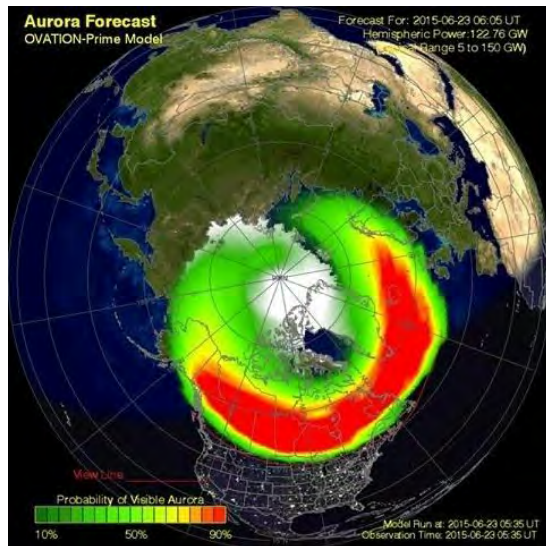
The aurora borealis (northern lights) are the result of electrons colliding with Earth's upper atmosphere. When space weather activity increases, the aurora may be visible. During large events, the aurora may be observed as far south as the U.S., Europe, and Asia. Keep in mind, to observe the aurora, the skies must be dark, clear, and free of clouds. To learn about the aurora <http://www.swpc.noaa.gov/phenomena/aurora> #SpaceWeather Photo of the December 2014 aurora taken in Alaska by Christopher Morse.

Twitter

The aurora may be seen over the US during major solar storms:

<http://www.swpc.noaa.gov/phenomena/aurora> (photo: Christopher Morse)





The [OVATION Aurora Forecast Model](#) shows the intensity and location of the aurora predicted for the time shown at the top of the map. This probability forecast is based on current solar wind conditions.

Note: A 3-day aurora forecast is now available as a [test product](#)!

Credit: NOAA

What are Solar Flares?

Facebook

Solar flares are huge explosions of electromagnetic radiation from the Sun lasting from minutes to hours. They are seen as a bright area on the sun in optical wavelengths and as bursts of noise in radio wavelengths. Solar flares occur in a large range of strengths, have emissions that travel at the speed of light and reach Earth in eight minutes. They can cause radio blackouts on the sunlit side of the Earth. To learn about radio blackouts visit

www.swpc.noaa.gov/phenomena/solar-flares-radio-blackouts #SpaceWeather

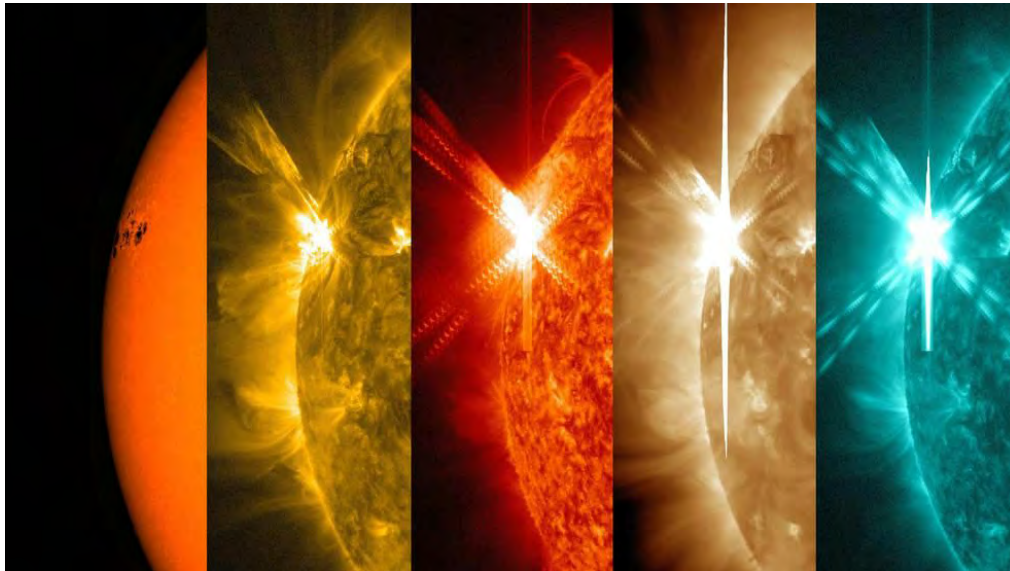
Twitter

Huge explosions from the Sun are called solar flares & can cause radio blackouts

<http://www.swpc.noaa.gov/phenomena/solar-flares-radio-blackouts> #SpaceWeather

Solar Flares may last minutes to hours and can have a major impact on radio communications.

www.swpc.noaa.gov



These images from the Solar Dynamics Observatory captured a solar flare on May 5, 2015. Credit: NASA

What are Coronal Mass Ejections?

Facebook

Coronal Mass Ejections (CMEs) are explosive eruptions of plasma from the Sun's outer atmosphere, the Corona. A CME typically carries roughly a billion tons of material outward from the Sun at millions of miles per hour (thousands of km/s). CMEs are not particularly bright and may take hours to fully erupt from the Sun and typically take 1-4 days to travel to Earth. To learn about CMEs visit: <http://www.swpc.noaa.gov/phenomena/coronal-mass-ejections>

#SpaceWeather Photo from NASA

Twitter

Coronal Mass Ejections are explosive outbursts from the Sun.

<http://www.swpc.noaa.gov/phenomena/coronal-mass-ejections> #SpaceWeather (photo @NASA)



This image from the Solar Dynamics Observatory captured this Coronal Mass Ejection (CME) image on April 16, 2012. Credit: NASA

What are the Impacts of a Geomagnetic Storm?

Facebook

While a geomagnetic storm can produce the beautiful aurora borealis, they can also damage power systems. The NOAA G-Scale rates geomagnetic storms on a scale of 1-5 - Learn more about this scale and the impacts of geomagnetic storms here:

<http://www.swpc.noaa.gov/noaa-scales-explanation> #SpaceWeather

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When a geomagnetic storm is happening, what will it impact?

<http://www.swpc.noaa.gov/noaa-scales-explanation> #SpaceWeather

Geomagnetic Storms

Scale	Description	Effect	Physical measure	Average Frequency (1 cycle = 11 years)
G 5	Extreme	Power systems: Widespread voltage control problems and protective system problems can occur, some grid systems may experience complete collapse or blackouts. Transformers may experience damage. Spacecraft operations: May experience extensive surface charging, problems with orientation, uplink/downlink and tracking satellites. Other systems: Pipeline currents can reach hundreds of amps, HF (high frequency) radio propagation may be impossible in many areas for one to two days, satellite navigation may be degraded for days, low-frequency radio navigation can be out for hours, and aurora has been seen as low as Florida and southern Texas (typically 40° geomagnetic lat.).	Kp = 9	4 per cycle (4 days per cycle)
G 4	Severe	Power systems: Possible widespread voltage control problems and some protective systems will mistakenly trip out key assets from the grid. Spacecraft operations: May experience surface charging and tracking problems, corrections may be needed for orientation problems. Other systems: Induced pipeline currents affect preventive measures, HF radio propagation sporadic, satellite navigation degraded for hours, low-frequency radio navigation disrupted, and aurora has been seen as low as Alabama and northern California (typically 45° geomagnetic lat.).	Kp = 8, including a 9-	100 per cycle (60 days per cycle)
G 3	Strong	Power systems: Voltage corrections may be required, false alarms triggered on some protection devices. Spacecraft operations: Surface charging may occur on satellite components, drag may increase on low-Earth-orbit satellites, and corrections may be needed for orientation problems. Other systems: Intermittent satellite navigation and low-frequency radio navigation problems may occur, HF radio may be intermittent, and aurora has been seen as low as Illinois and Oregon (typically 50° geomagnetic lat.).	Kp = 7	200 per cycle (130 days per cycle)
G 2	Moderate	Power systems: High-latitude power systems may experience voltage alarms, long-duration storms may cause transformer damage. Spacecraft operations: Corrective actions to orientation may be required by ground control; possible changes in drag affect orbit predictions. Other systems: HF radio propagation can fade at higher latitudes, and aurora has been seen as low as New York and Idaho (typically 55° geomagnetic lat.).	Kp = 6	600 per cycle (360 days per cycle)
G 1	Minor	Power systems: Weak power grid fluctuations can occur. Spacecraft operations: Minor impact on satellite operations possible. Other systems: Migratory animals are affected at this and higher levels; aurora is commonly visible at high latitudes (northern Michigan and Maine).	Kp = 5	1700 per cycle (900 days per cycle)

What are the impacts of a Solar Radiation Storm?

Facebook

Solar radiation storms are infrequent but can result in detrimental impacts to satellites in space and people on Earth. These storms are rated on the NOAA S-scale from 1-5; Learn more:

<http://www.swpc.noaa.gov/noaa-scales-explanation> #SpaceWeather

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When a solar radiation storm is happening, what will it impact?

<http://www.swpc.noaa.gov/noaa-scales-explanation> #SpaceWeather

Solar Radiation Storms

Scale	Description	Effect	Physical measure (Flux level of ≥ 10 MeV particles)	Average Frequency (1 cycle = 11 years)
S 5	Extreme	Biological: Unavoidable high radiation hazard to astronauts on EVA (extra-vehicular activity); passengers and crew in high-flying aircraft at high latitudes may be exposed to radiation risk. Satellite operations: Satellites may be rendered useless, memory impacts can cause loss of control, may cause serious noise in image data, star-trackers may be unable to locate sources; permanent damage to solar panels possible. Other systems: Complete blackout of HF (high frequency) communications possible through the polar regions, and position errors make navigation operations extremely difficult.	10^5	Fewer than 1 per cycle
S 4	Severe	Biological: Unavoidable radiation hazard to astronauts on EVA; passengers and crew in high-flying aircraft at high latitudes may be exposed to radiation risk. Satellite operations: May experience memory device problems and noise on imaging systems; star-tracker problems may cause orientation problems, and solar panel efficiency can be degraded. Other systems: Blackout of HF radio communications through the polar regions and increased navigation errors over several days are likely.	10^4	3 per cycle
S 3	Strong	Biological: Radiation hazard avoidance recommended for astronauts on EVA; passengers and crew in high-flying aircraft at high latitudes may be exposed to radiation risk. Satellite operations: Single-event upsets, noise in imaging systems, and slight reduction of efficiency in solar panel are likely. Other systems: Degraded HF radio propagation through the polar regions and navigation position errors likely.	10^3	10 per cycle
S 2	Moderate	Biological: Passengers and crew in high-flying aircraft at high latitudes may be exposed to elevated radiation risk. Satellite operations: Infrequent single-event upsets possible. Other systems: Small effects on HF propagation through the polar regions and navigation at polar cap locations possibly affected.	10^2	25 per cycle
S 1	Minor	Biological: None. Satellite operations: None. Other systems: Minor impacts on HF radio in the polar regions.	10	50 per cycle

What are the Impacts of a Radio Blackout?

Facebook

Radio blackouts from space weather can impact high frequency (HF) radio communications, which impacts pilots and mariners. These blackouts are rated on the NOAA R-scale; Learn more: <http://www.swpc.noaa.gov/noaa-scales-explanation> #SpaceWeather

Twitter

When a radio blackout is happening due to space weather, what will it impact?
<http://www.swpc.noaa.gov/noaa-scales-explanation> #SpaceWeather

Radio Blackouts

Scale	Description	Effect	Physical measure	Average Frequency (1 cycle = 11 years)
R 5	Extreme	HF Radio: Complete HF (high frequency) radio blackout on the entire sunlit side of the Earth lasting for a number of hours. This results in no HF radio contact with mariners and en route aviators in this sector. Navigation: Low-frequency navigation signals used by maritime and general aviation systems experience outages on the sunlit side of the Earth for many hours, causing loss in positioning. Increased satellite navigation errors in positioning for several hours on the sunlit side of Earth, which may spread into the night side.	X20 (2×10^{-3})	Less than 1 per cycle
R 4	Severe	HF Radio: HF radio communication blackout on most of the sunlit side of Earth for one to two hours. HF radio contact lost during this time. Navigation: Outages of low-frequency navigation signals cause increased error in positioning for one to two hours. Minor disruptions of satellite navigation possible on the sunlit side of Earth.	X10 (10^{-3})	8 per cycle (8 days per cycle)
R 3	Strong	HF Radio: Wide area blackout of HF radio communication, loss of radio contact for about an hour on sunlit side of Earth. Navigation: Low-frequency navigation signals degraded for about an hour.	X1 (10^{-4})	175 per cycle (140 days per cycle)
R 2	Moderate	HF Radio: Limited blackout of HF radio communication on sunlit side, loss of radio contact for tens of minutes. Navigation: Degradation of low-frequency navigation signals for tens of minutes.	M5 (5×10^{-5})	350 per cycle (300 days per cycle)
R 1	Minor	HF Radio: Weak or minor degradation of HF radio communication on sunlit side, occasional loss of radio contact. Navigation: Low-frequency navigation signals degraded for brief intervals.	M1 (10^{-5})	2000 per cycle (950 days per cycle)

